

WE CLAIM:

1 1. A method for producing a boride layer on a surface by plasma boronizing  
2 comprising:  
3 supplying a gas mixture containing a boron-releasing gas to a treatment  
4 chamber of a reactor;  
5 generating a glow discharge in the reactor;  
6 determining the amount of at least one excited boron-releasing gas product  
7 in the glow discharge; and  
8 selecting production parameters of the plasma generated in the treatment  
9 chamber of the reactor so that a minimum <sup>1/2</sup> and/or maximum value of the determined  
10 excited boron-releasing gas product and/or a minimum or maximum value of a relation of  
11 one or more of the determined excited boron-releasing gas products to another glow  
12 discharge product are maintained.

1 2. A method for producing a boride layer on a surface by plasma boronizing  
2 comprising:  
3 supplying a gas mixture containing a boron-releasing gas to a reactor; and  
4 generating glow discharge in the reactor using a pulsed DC voltage source having a ratio  
5 of voltage pulse duration to subsequent pulse pause duration which is greater than 1.1:1.

1 3. A method for producing a boride layer on a surface by plasma boronizing  
2 comprising:  
3 supplying a gas mixture containing a boron-releasing gas to a reactor; and  
4 generating a glow discharge in the reactor by applying a DC voltage in  
5 pulses having a pulse period of less than 230  $\mu$ s.

1 4. A method for producing a boride layer on a surface by plasma boronizing  
2 comprising:  
3 supplying a gas mixture containing a boron-releasing gas to reactor; and  
4 generating a glow discharge in the reactor while maintaining the gas  
5 mixture at a selected low treatment temperature during a first stage to first produce a  
6 relatively thin, dense boride layer and prevent formation of halogenides which cause  
7 formation of pores, and maintaining the gas mixture at a higher temperature during in a  
8 second stage.

1 5. A method according to claim 1 wherein the glow discharge is produced  
2 using a pulsed DC voltage source having a ratio of voltage pulse duration to subsequent  
3 pulse pause duration which is greater than 1.1:1.

1 6. A method according to claim 1 wherein the glow discharge is generated by  
2 applying DC voltage pulses having a pulse period of less than 230  $\mu$ s.

1 7. A method according to claim 1 wherein the method includes a first stage  
2 during which the gas mixture is maintained at a selected low temperature to prevent  
3 formation of halogenides which cause formation of pores to first produce a relatively thin,  
4 dense boride layer, followed by a second stage during which the gas mixture is  
5 maintained at a higher temperature.

1 8. A method according to claim 2 wherein the glow discharge is generated by  
2 applying a DC voltage in pulses having a pulse period of less than 230  $\mu$ s.

1 9. A method according to claim 2 wherein the method includes a first stage  
2 during which the gas mixture is maintained at a selected low temperature to prevent  
3 formation of halogenides which cause formation of pores to first produce a relatively thin,  
4 dense boride layer, followed by a second stage during which the gas mixture is  
5 maintained at a higher temperature.

1 10. A method according to claim 3 wherein the method includes a first stage  
2 during which the gas mixture is maintained at a selected low temperature to prevent  
3 formation of halogenides which cause formation of pores to first produce a relatively thin,  
4 dense boride layer followed by a second stage during which the gas mixture is maintained  
5 at a higher temperature.

11. A method according to claim 2 or claim 5 including determining the amount of excited boron-releasing gas in the reactor at least in a relative manner.

12. A method according to claim 11 including determining spectroscopically the amount of excited boron-releasing gas in the reactor.

13. A method according to claim 11 including determining the amount of excited boron in the reactor at least as a function of the amount of excited boron-releasing gas in the reactor.

14. A method according to claim 13 wherein, in order to form a minimum or maximum value of the excited boron-releasing gas content, the determined amount of the excited boron-releasing gas is set in relation to a determined amount of at least one further boron-releasing gas product.

15. A method according to any one of claims 1-4 wherein a gas mixture is supplied which contains a boron trihalide as a boron-releasing gas in a concentration greater than about 1% by volume, along with hydrogen gas and, optionally, a noble gas.

- 1 16. A method according to any one of claims 1-4 wherein the glow discharge  
2 is generated by applying a pulsed DC voltage which has a ratio of the voltage pulse  
3 duration to the subsequent pulse pause duration in the range from about 1.1:1 to 5:1.

- 1 17. A method according to claim 16 wherein the ratio is in the range from  
2 about 1.5:1 to 3.5:1.

- 1 18. A method according to any one of claims 1-4 wherein a pulsed DC voltage  
2 having a pulse period of less than about 210  $\mu$ s is used for generating the glow discharge.

- 1 19. A method according to claim 18 wherein the pulsed DC voltage has a  
2 pulse period  $\geq 50 \mu$ s.

- 1 20. A method according to claim 19 wherein the voltage of the pulsed  
2 DC voltage used for generating the glow discharge in the range between about 500 volts  
3 and about 1000 volts.

- 1 21. A method according to claim 20 wherein the voltage is in the range  
2 between about 650 volts and about 800 volts.

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29. A method according to any one of claims 1-4 wherein the boron-releasing gas is one of  $\text{BCl}_3$ ,  $\text{BF}_3$  and mixtures thereof.

30. An arrangement for producing a boride layer on a surface by plasma boronizing comprising:  
a reactor having a treatment chamber;  
a glow discharge generator in the reactor chamber;  
a gas supply device through which a gas mixture containing a boron-releasing gas is supplied to the reactor; and  
a pulsed DC voltage source for applying pulsed DC voltage with a controllable pulse width and/or pulse pause.

31. An arrangement according to claim 30 including at least one mass flow meter for measuring and/or controlling the composition and/or the flow rate of at least one of the gases in the gas mixture.

32. An arrangement according to claim 31 including at least two flow meters for measuring and/or controlling the flow rate of the boron-releasing gas and/or hydrogen gas and/or a noble gas.

1 33. An arrangement to claim 30 including a pressure gauge for measuring the  
2 pressure in the reactor.

1 34. An arrangement according to claim 33 including a computer for  
2 controlling the measurement of pressure in the treatment chamber by the pressure gauge.

1 35. An arrangement according to claim 30 including a gas spraying device for  
2 distributing the gas mixture into the reactor treatment chamber.

1 36. An arrangement according to claim 30 including a cooled gas inlet for the  
2 boron-releasing gas.

1 37. An arrangement according to claim 30 including a gas purification device  
2 connected to the treatment chamber for waste gas treatment.

1 38. An arrangement according to claim 37 including a vacuum pump  
2 connected to the gas purification device.

1 39. An arrangement according to claim 30 including heating means in the  
2 reactor for achieving a desired treatment temperature.

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